Chapter 17: Money

Graduate Macroeconomics Slides

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Outline

Motivation and Overview

Key points:

- Until now: Real-variable-focused models (no explicit role for money).
- In broader macroeconomics: money, inflation, and monetary policy are central.
- Monetary policy is a major tool for governments (via central banks).
- New perspective: Understanding why and how fiat money can hold value.

Topics to be covered:

- Inflation, welfare costs, and redistributive effects.
- Monetary policy tools and historical context.
- Theoretical frameworks: Overlapping-generations (OLG) model and beyond.
- Equilibrium indeterminacy and hyperinflations.

Historical Context: Inflation & Policy

Recent inflation trends:

- Pre-2021: Advanced economies maintained low inflation ($< 5\%$) for decades.
- Post-2021: Supply-chain disruptions, global shocks (e.g., 2020 pandemic, 2022 war) drove inflation $> 5\%$.

Consequences and policy:

- Renewed urgency to control inflation.
- In developing/emerging economies, high inflation or hyperinflation remains frequent.
- Central banks target stable inflation (often around 2%).

Money in Macroeconomics

Key questions:

- What determines the price level and causes inflation?
- How does inflation impact welfare and inequality?
- How do monetary policy and government interventions shape inflation?

Outline of this chapter's approach:

- Introduce theories of money: Why fiat currency can have value.
- Study basic frameworks with flexible prices (OLG and infinite horizon).
- Contrast with New Keynesian (sticky-price) approaches.

Indeterminacy and Hyperinflation

Indeterminacy in monetary economies:

- Many equilibria may exist: e.g., stable vs. hyperinflationary paths.
- Milton Friedman's view: inflation arises from money-supply growth.
- But in theoretical models, *coordination* on different price paths also matters.

Policy implications:

- New Keynesian models often ignore explicit money demand, focusing on nominal rigidities.
- We explore classical flexible-price models here and see how money could matter.

Basic OLG Setup

Environment:

- Two-period lived agents (young and old).
- Endowment (c_y, c_o) for each cohort, preferences typically $\log c_y + \log c_o$.
- Initially, an older generation may hold the stock M of fiat money.

Key question:

- Can intrinsically useless *fiat money* be valued?

Mechanics:

- Money trades at price $p_{m,t}$ in terms of consumption.
- No storage or capital (simplest version).

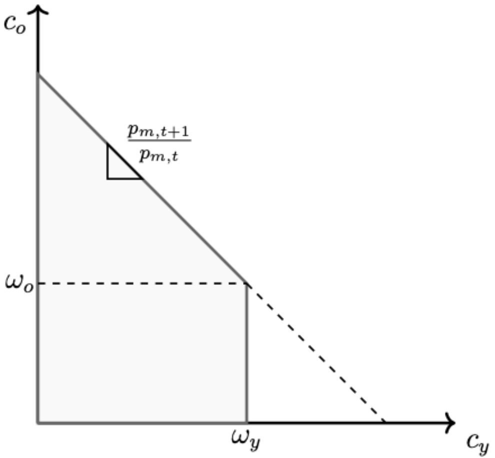

Figure 17.1: Budget set in the economy with fiat money

Equilibrium with Valued Money

Consumer's problem:

$$\max_{\{c_y, c_o, M'\}} \log c_y + \log c_o$$

subject to budget constraints:

$$c_y + p_{m,t} M' = c_y, \quad c_o = c_o + p_{m,t+1} M'.$$

Outcome:

- If $p_{m,t} > 0$, money can serve as a store of value.
- Agents optimally choose nonnegative M' (cannot short money).

Multiple Equilibria

Case 1: $p_{m,t} = 0$ for all t

- Money is worthless, no one holds it.
- Occurs if $c_y \leq c_o$ (no need to save).

Case 2: $p_{m,t} > 0$

- When $c_y > c_o$, money solves the saving "problem."
- *Stationary* valued equilibrium: $p_{m,t} = \overline{p}_m$.
- *Non-stationary* paths: $p_{m,t}$ can converge to 0 (hyperinflation).

Welfare:

- Stationary monetary equilibrium can Pareto dominate non-monetary equilibria when $c_y > c_o$.

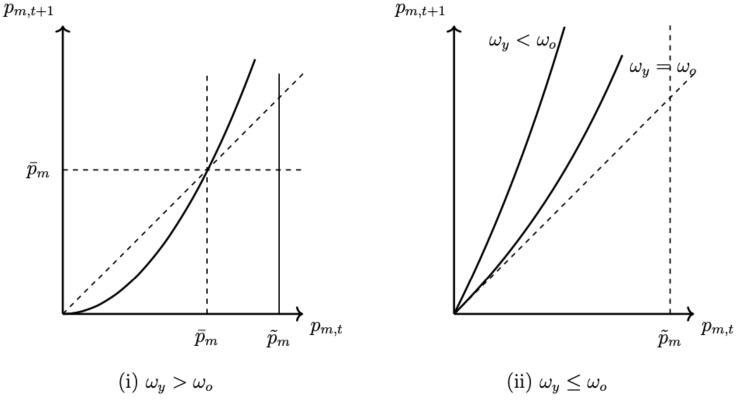

Figure 17.2: Price Dynamics

Extensions in OLG

Adding capital or government policy:

- With capital, if real interest > 1, money may lose value.
- Introducing money growth (seigniorage) finances government operations.
- Open-market operations: interplay of bonds vs. money as stores of value.

Lessons so far:

- OLG environment provides a natural reason for fiat money to hold value if no better asset is available.
- Multiple equilibria arise from self-fulfilling beliefs on future money value.

Money without Frictions: No Value

Representative agent, infinite horizon:

$$\max \sum_{t=0}^{\infty} \beta^t u(c_t, \ell_t)$$

Budget constraint:

$$c_t + q_t a_{t+1} + p_{m,t} M_{t+1} \;=\; w_t(1-\ell_t) + a_t + p_{m,t} M_t - \tau_t, \quad M_{t+1} \geq 0.$$

Finding that:

- If money yields no liquidity benefit and $i_t > 0$, then money is strictly dominated by interest-bearing bonds $\implies$ $p_{m,t} = 0$ in equilibrium.
- Even if $i_t = 0$, transversality conditions typically force $M_t / P_t \to 0$.

Reduced-Form Approaches

To give money value, impose liquidity role:

1. *Cash-in-advance (CIA)*:
$$c_t \leq \frac{M_t}{P_t}.$$
2. *Money in transactions costs*: lowers transactions cost if M_t/P_t is higher.
3. *Money in utility*: $u(c_t, M_t/P_t)$, direct utility from holding balances.

Key idea:

- Money is not purely a store of value; it reduces transaction frictions.
- Implies a demand function for real balances: $M_t/P_t = f(i_t, y_t)$.

Cash-in-Advance Model

Setup:

- CIA constraint: $c_t \leq m_t \equiv M_t/P_t$.
- Budget: $m_{t+1}p_{m,t+1} + a_{t+1} \leq a_t + m_t - c_t + w_t(1 - \ell_t) - \tau_t$.

Implications:

- Typically, CIA is *binding*, so $c_t = m_t$.
- If M is constant, then $\frac{M}{P} = c \implies P = M/c \implies$ quantity theory: $MV = PY$.
- Distortion arises: labor income earned at t cannot be used for t consumption.

The Friedman Rule

Optimal policy under CIA:

- High nominal interest i distorts money demand, lowers c_t.
- **Friedman rule**: set $i = 0$ (or deflation $=$ real rate), so money $\leftrightarrow$ bonds are perfect substitutes.
- Achieves Pareto efficiency in simple CIA setups.
- Usually means contracting the money supply at rate β (lump-sum transfers/taxes).

Quantity Theory of Money, Setup and Measurement Choices

- The QTM links money, prices, and transactions via the identity

$$M_t V_t = P_t Y_t \quad \Rightarrow \quad \pi_t \equiv \Delta \log P_t \approx \mu_t - g_{Y,t} + \Delta v_t,$$

  where $\mu_t = \Delta \log M_t$ and $v_t = \log V_t$. Under *stable velocity* ($\Delta v_t \approx 0$), inflation moves one-for-one with money growth in the long run (Sargent and Surico, 2011).

- Empirical implementation requires a monetary aggregate (M), a transactions proxy, and an opportunity cost of holding money. Screens use $M2$, GDP as transactions, and short rates (e.g., Commercial Paper) as the opportunity cost (Sargent and Surico, 2011).

- Monetary aggregation can matter: simple-sum $M1/M2$ versus Divisia indexes that weight components by user cost (Barnett, 1980). Institutional changes (e.g., Regulation Q, sweep accounts, electronic payments) shift measured money demand (Lucas and Nicolini, 2015).
- To focus on long-run comovement, the analysis filters annual series with symmetric 15-year moving averages and also inspects five historical subperiods (1902–1928, 1929–1954, 1955–1983, 1984–2005, 2006–2023) (Sargent and Surico, 2011).

Money Growth and Inflation: Long-Run Regression

- Estimate on filtered data:

$$\pi_t^{(15y)} = \alpha + \beta \, \Delta \log M2_t^{(15y)} + \varepsilon_t$$

- QTM benchmark is $\beta = 1$.

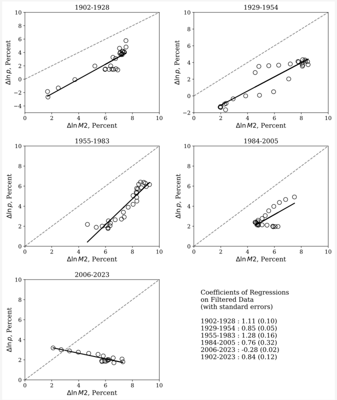

Figure 17.3: Inflation and money growth

- Intuition: During high-inflation eras, velocity trends are small and $\beta \approx 1$. Under inflation targeting and QE, velocity shifts dominate, breaking one-for-one comovement.

Is Money Demand Stable? (Velocity as a Function of Rates)

- A canonical long-run money demand is

$$\log\left(\frac{M2_t}{Y_t}\right) = \kappa - \eta\, i_t + u_t,$$

  where i_t is the short rate measuring the user cost of money. Stability means a roughly constant $\eta > 0$ and stationary u_t (Sargent and Surico, 2011).

- On filtered 15-year trends, $M2/GDP$ co-moves negatively with the short rate, consistent with $\eta > 0$.

- Across historical sub-samples, OLS links of $M2/GDP$ to i_t are weak or insignificant, implying time-varying velocity and structural breaks (financial innovation, regulation, IT, and QE) (Lucas and Nicolini, 2015; Barnett, 1980).

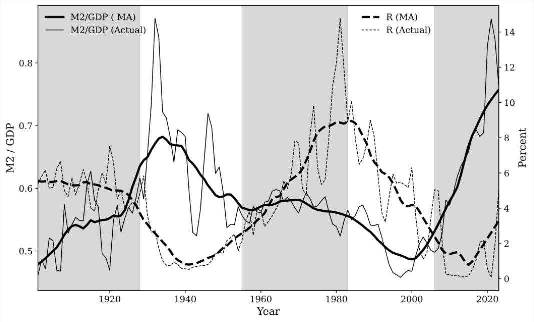

Figure 17.4: Inflation and money growth

What We Learn from the U.S. Historical Data

- **Support for QTM is regime-dependent.** In high-inflation periods (1960s–1970s), β is near one and money growth tracks inflation, consistent with $\Delta v_t \approx 0$ (Sargent and Surico, 2011).
- **Velocity instability weakens QTM.** Under the Great Moderation, inflation targeting, and QE, financial innovation and policy frameworks shift velocity ($\Delta v_t \neq 0$), so inflation responds less than one-for-one—or even negatively—to money growth (Lucas and Nicolini, 2015).
- **Measurement matters.** Simple-sum $M2$ aggregates may blur the link; Divisia aggregation and user-cost corrections can restore stability in some samples (Barnett, 1980).
- **Takeaway for practice.** For long-run, high-inflation environments, QTM remains a useful approximation. For low-inflation, financially evolving economies, incorporate an explicit velocity (or money-demand) block and allow for structural breaks.

Money-in-Utility or Transactions-Cost Models

Key results:

- Real balances yield *services*, so M_t/P_t is demanded despite $i > 0$.
- **Money demand** often of form: $\frac{M_t}{P_t} = c_t \cdot f\left(\frac{i_t}{1+i_t}\right)$.
- Friedman rule can still be optimal if it *satiates* agents in real balances.

Comparison to CIA:

- More elastic money demand.
- Possibly smaller welfare loss from modest $i > 0$.

Indeterminacy: Multiple Paths

Sources of indeterminacy:

- Beliefs about future value of money can be self-fulfilling.
- Example: OLG model or CIA model with money growth $\gamma > 1$ can yield hyperinflation paths.

Monetary policy design:

- Setting M_{t+1} exogenously (money growth) can leave initial price P_0 undetermined.
- *Interest-rate pegs* ($i_t =$ const) often cause price-level indeterminacy.
- **Interest rate rules** à la Taylor can pin down P_t uniquely if sufficiently responsive to inflation.

Taylor Rule and Price Determination

A typical rule: $i_t = \phi(\pi_t), \quad \phi'(\cdot) > 0.$

- If monetary policy *raises* i_t aggressively when π_t is above target, this can eliminate explosive paths.
- Leads to a unique (local) equilibrium with P_t or π_t pinned down.

Contrast: Pure peg

- $i_t = \bar{i}$ fixed $\implies$ continuum of possible P_0 values and dynamic paths (indeterminate).

Cashless Limit ((Woodford, 2003))

Idea:

- Let real balances approach 0 in an environment with *some* liquidity friction.
- Monetary policy sets interest rates to maintain stable inflation.
- In the limit, money demand is negligible: model can be written without M explicitly.

Implication:

- Under certain assumptions (e.g., separable utility $u(c, m)$), real side and P_t determination does not rely on M_t.
- Justifies "cashless" New Keynesian models (focus on interest rules + price stickiness).

Government Budget Constraint

$G_t + (1 + i_{t-1})B_{t-1} \; = \; T_t + B_t + (M_t - M_{t-1})$, **or in present-value form:** $\sum_{t=0}^{\infty} q^t (G_t - T_t) \; = \; \sum_{t=0}^{\infty} q^t (M_t - M_{t-1})$.

- *Seigniorage*: Financing part of deficits via printing money.
- With *positive* nominal interest i_t, substituting money for bonds can reduce interest cost for government.

"Unpleasant Monetarist Arithmetic" ((Sargent and Wallace, 1985)

- Reducing M_t today by issuing more B_t can raise future *interest obligations*, forcing higher M_{t+k} expansions to repay.
- Paradox: Trying to decrease inflation now can raise it in the future if fiscal surpluses don't adjust.

Irrelevance of Open-Market Operations:

- If $i = 0$ and M, B are *perfect substitutes*, shifting between them does nothing in equilibrium.
- Interpreted as "QE is irrelevant" at the zero lower bound, absent other frictions.

Fiscal Theory of the Price Level (FTPL)

Core idea:

- If the government fixes $(B_0, \{G_t, T_t\}_{t=0}^{\infty})$ exogenously, then P_0 adjusts to ensure $(1+i_{-1}), B_0/P_0 \;=\;$ present value of primary surpluses.
- *Monetary dominance* vs. *fiscal dominance*: policy mix matters for price determinacy.

Example:

- Interest-rate peg $i_t = \bar{i}$ is typically indeterminate for P_0.
- But if fiscal surpluses are pegged to offset any mismatch, P_0 *can* be pinned down uniquely by FTPL.

Missing Assets Perspective

Huggett model example:

- Borrowing constraints $\implies$ autarky or limited insurance.
- If real interest rate is negative, *fiat money* might help smooth consumption.
- Money emerges as partial replacement of absent complete markets.

Townsend Turnpike idea:

- Alternating endowments with no borrowing $\implies$ scope for a medium of exchange.

Multiple Fiat Currencies

(Kareken and Wallace, 1981) **Indeterminacy:**

- If currencies differ only in labels, exchange rate e_t is not pinned down.
- "Gresham's law" possibility: Higher growth currency might drive out the other in equilibrium, or vice versa.

Reduced-form model:

- If each currency is demanded for distinct goods or each has separate "liquidity" benefits, the exchange rate is determined by supply-demand fundamentals.

Exchange Rates in Reduced-Form Models

- (Lucas, 1982) approach: each currency is needed to purchase certain goods $\Longrightarrow$ well-defined exchange rate from relative demands.
- Purchasing Power Parity (PPP) and Interest Rate Parity hold in frictionless, flexible-price setups.
- Real-world: PPP often violated short-run due to sticky prices.

Bottom line:

- No single universal determination of e_t if currencies are perfect substitutes.
- Additional structure (segmented markets, local currency pricing, etc.) is key.

Crypto-Currencies

- **Digital "fiat" objects** with no intrinsic backing.
- Theoretically: same "store of value" issue as multiple fiat currencies.
- High volatility suggests strong coordination problem (like OLG models).
- Potential liquidity premium if certain transactions *require* crypto or if anonymity is valuable.

Summary: Models can easily incorporate new "monies," but predicting their exchange value requires assumptions about *use cases* and *beliefs*.

(Kiyotaki and Wright, 1989) Framework

Absence of double coincidence:

- Each agent produces one good but consumes another.
- Decentralized, pairwise random matching $\implies$ bartering often fails.

Fiat money:

- Intrinsically worthless object can facilitate exchange if widely accepted.
- Multiple equilibria: “money accepted by everyone” or “worthless” equilibrium.

Search and Matching Frictions

Key points of search-theoretic models:

- Microfoundation of why money helps overcome trading frictions.
- *Storage* cost or technology can determine which good serves as medium of exchange.
- "Lagos-Wright" variant allows smoother modeling with partial centralization each period.

Implications:

- *Deep* reason for money: *lack of record-keeping and double coincidence of wants*.
- The analysis can yield robust policy conclusions on how changes in money supply affect exchange.

Chapter Summary

Main takeaways:

- Fiat money can have value if:
  - No dominating asset (**OLG store-of-value**),
  - Or it yields "liquidity services" (CIA, transactions cost, money-in-utility),
  - Or missing markets require a medium of exchange.
- Multiple equilibria: *indeterminacy* is common.
- Monetary policy rules can "select" equilibria or provide unique price-level paths (e.g., Taylor rule).
- Fiscal policy constraints connect seigniorage, government debt, and inflation outcomes.

Looking Ahead

Next steps in the textbook (Chapter 18):

- *New Keynesian model*: sticky prices, nominal rigidities, interest rate rules.
- Monetary policy has real effects in the short run.
- Money *per se* is often absent, focusing on the *cashless limit* argument.

Applications:

- Explaining actual central bank policies, inflation targeting, and interest rate pegs.
- Understanding *liquidity traps*, QE, and extended zero-lower-bound episodes.

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Thank you!

Questions or comments?

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